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IRON CASTINGS.

(Written for Engineering News.)

More has been written about cast iron than about any other material used for purposes of construction, and yet very little about the precautions to be taken in order to render it an efficient servant. The term cast iron covers an exceedingly great range, from the white, hard "spiegel" to the soft, blue-grey of "No. 1, Foundry," and it is used both for pig iron and for the finished product of the moulder's work. In common usage it is restricted to the latter, and in that sense alone do we propose to apply it.

Cast iron, then, is iron which has been run into and has taken the form of a mould, previously prepared to receive it. The ease with which this can be brought about appears at first sight very great, and seems scarcely to call for attention, much less experience; but there are few things more difficult than to make a perfect casting, and some of the requisite points to be looked after will be here specified.

First:—As a matter of course the casting should be like the pattern from which the mould was made.

Second: It should be free from surface defects, blowholes, irregularities of surface, variations of thickness, air-bubbles, blisters and "cold shots."

Third:—The metal should be homogeneous.

To secure all of these results the greatest care is needed, and there are so many causes operating to produce defects that we must give them a little attention.

One of the great sources of difficulty is the variety of the material supplied to the cupola or melting furnace, and this is partially due to the variations in the run of the pig iron used as well as to the variations of quality in the scrap iron. From these causes there is a constant trouble in producing a good "mixture," and in castings for different purposes very different grades are employed. In foundries which have a uniform run of work and which make pieces differing but little in weight, this can be regulated much more easily than where the work varies greatly from day to day, and especially when there is a great range in the magnitude of each day's work.

The quality of the face or surface and the appearance of the casting are very dependent on the quality and size of the particles of sand employed, and the manner in which the mould has been prepared. The sand cannot always be obtained of the desired quality, and many troubles are due to the manner of using it.

The earth or sand must have at least a certain amount of cohesion, and the moulder's test seems to be the only reliable one. When a portion of sand is taken up and gripped in the hand, it should adhere together, and the mass will then have in it the marks of the fingers, with projecting ridges concave on the sides. If now the lump of sand be held between the tips of the fingers and thumb and shaken, none of the sand should be detached; if it will stand this rough test, it has at least the requisite cohesion.

Passing over the delicate work of the pattern-maker and the moulder, often by no means an easy task for either of them, let us suppose the fluid iron to be just coming in contact with the suface of the mould, and let us consider the action. There is a sudden rise of temperature in the sand near the iron, and it may become partially fused; there is a generation of steam and of gases formed from the vegetable matter in the sand. These gases, rapidly formed, of the tension due to an intense heat, must escape, and it is essential that they should find vent through the sand, and out into the air at holes provided for that purpose in the flask.

Some of these gases are inflammable and highly explosive, being formed by distillation of vegetable matter, and they are therefore lighted at once, to avoid explosions which might run back into the sand and thus break the fair surface of the mould, causing "scales" or projections on the face of the casting. In order to afford free escape to these gases the sand must not be rammed too hard, and the amount of force to be applied to the rammer must be varied with the different kinds of sand, with its quality, and with the proportion of vegetable matter used as binding material or found in the earth employed. If the sand be too easily fused, it will adhere to the castings, and they will not come out clean; this will happen if the sand contains lime or other bases. Sometimes a thin layer of rust forms on the surface, and the sand unites, making a silicate of iron. This is not a common occurence, but it may happen.

Exactly what does take place when the metal strikes the surface of the mould is of course unknown, but, if the surface is not hard enough to resist the shock of the wave or surge of the iron, a bad casting is the result. The surface of the mould is usually covered with fine carbon which, by forming a thin layer of non-fusible material, in a measure protects the sand from the heat, but which may also render the escape of the gas more difficult, and thus cause a break in the surface. Any free water will cause an explosion of steam, but, as a certain degree of moisture increases the adhesion of the sand and can never be entirely gotten rid of, this moisture will be driven off as vapor.

There are two classes of moulds those made with air-dried earth, and known as "green sand," and those made with "loam" or "dry sand," in which a wet paste of earth is used and afterwards dried by a fire. The surfaces of the moulds so made are very different and are treated differently. To "green sand" moulds the carbon mentioned above is dusted on from a bag, but to the "dry sand" is applied in a liquid form as a "black wash," and dried with the sand. The latter class of moulds when well dried have much less moisture in them, and the generation of steam by the heat of the metal is much less than with the former class; hence the risk of breaking the surface of the mould is not nearly so great as with the green sand. Sometimes a portion of gas will, instead of going through the sand, try to escape by passing into the metal as a bubble, which, if the iron is fluid enough, will rise to the highest part of the casting, where it may escape into the "risers" or "gates," or stay in some angle of the piece.

Springing of the flasks, causing "fins" and "run-outs," and lifting of the top or "cope" of the flask are caused by the hydrostatic pressure, if we may so term it, of the fluid, amounting to three lbs. per square inch for every foot in height of the casting,—an amount which may sometimes be counted by tons of pressure on large moulds, and which can only be successfully resisted by the exercise of skill and judgment. The springing and rising of "cores" is caused by the same pressure, and can only be prevented by great care in supporting the core in position and holding it against the upward pressure. This is usually done by small pieces of round iron which extend from the core to the mould and are built into the sand at the ends. These pieces are called "chaplets." If the metal is not hot, it will chill and unite with them imperfectly; if galvanized chaplets are used, the metal will unite perfectly.

But perhaps the most fruitful source of trouble in casting is the shrinkage. Whether cast iron in the melted form is of greater or less specific gravity than when in the solid condition is still a disputed question, but it is well-known that, with the metal once in the solid form, a very decided increase in density accompanies the fall in temperature, so that all patterns must be made larger than the finished work by an amount which varies, but which is commonly stated as one-eighth of an inch to the foot.

One very inconvenient fact for the engineer is that the strongest irons are apt to shrink the most, and give the most trouble. With castings which vary in thickness in different portions difficulty may always be expected. The thinner portions, parting first with their heat, will be the first to set; then the thicker ones which cool afterwords, having more area to resist the stress caused in shrinking, will pull the other parts out of shape. The rule in designing is always to avoid variations in thickness, if it can be done. The internal stress produced in this manner is often very great indeed; it may, and frequently does, by itself cause fractures, and more often when aided by changes and extremes of temperature. Even if this does not occur, many failures when the pieces were exposed to shock, wibration or load, can be raced to the existance of strains from unequal cooling.

If the iron is not sufficiently fluid when it is poured into the mould, it solidifies very quickly, and, if there is any intermission in the flow of the metal, there is a fold of the surface which is known as a "cold shot."

We have now very briefly reviewed the principal defecets to which castings are exposed, and will only say that the science of founding is by no means exhausted as a study, and that it is one of the most difficult arts to acquire. At some future time we will discuss some of the uses and abuses of cast iron. S.

Canadian Memoranda.

I observe that your correspondents are considerably exercised about the metric system in measurement. Allow me to suggest that most of the objections to the change of system would either be obviated or removed, by having dividers, or compassers, with a circular index, similar to the circular guide used on carpenters' dividers and compasses, on one side of which the distances of the points asunder, are expressed in the old system of inches etc., and on the other side marked with the new system in millimeters, etc. The measurements on a plan made in inches would thus on a glance be converted and shown on the metric system. To compensate for wear in the points each leg ought to be able to be drawn out, and fixed when adjusted by set screw; they would only want adjustment after being sharpened, possibly once a year.

You are strong on the subject of waterworks; the "quality" of the water as well as the volume obtained should be particularly examined. In some water works with which the writer was well acquainted, the water was obtained from an artesian well which had pierced through the chalk into the green sand, and was beautifully clear. It had such an effect on the Iron pipes however, that it always reached the customer in a roiled and more or less muddy state—so much so as to injure the popularity of the works greatly. E. L. C.

Toronto, Ont., April 26th.

The Delaware & Hudson Canal Company reduced wages ten per cent, on the 1st of April. Consequently repairmen are now working for ninety cents per day.

Dubuque, Iowa, is jubilant over the prospect of a pontoon bridge, the Government engineers having consented to the erection of one at Eagle Point, two miles above the city.

New Developments in Steam Engineering.

BY PROF. CHANNING WHITAKER.

Read before the Society of Arts of the Mass. Inst. of Technology.

De Pambour thought that saturated steam expanding in a cylinder followed the laws of Mariotte and Gay Lussac. He fancied that the steam remained saturated during the expansion, and that the weight of steam present in the cylinder was constant throughout the expansion. We now know that these ideas are not consistent with each other. De Pambour's views were, formerly, generally accepted, and many practical engineers to-day refer to the law of Mariotte as representing the expansion of strain in a theoretically perfect engine.

That law is, that the pressure is inversely proportional to the volume. The mathematical expression for it is

$$p\,v = p_0 v_0 = \text{constant};$$

in which p = the pressure, and v the volume of the steam. The curve representing the curve representing the law of Mariotte is easily drawn by rectangular coordinates, where vertical distances represent pressures and horizontal distances represent volumes, as is the case upon an indicator diagram. Of course as the volume doubles the pressure reduces to one half.

Regnault's justly celebrated experiments have given us most of the facts upon which our knowledge of the nature of steam is based. Both Rankine at Glasgow and Zeuner at Zurich calculated by interesting mathematical processes, with data from Regnault's experiments, the volume which would be occupied by a unit of weight of saturated steam under different pressures. Had their results been absolutely true we should have been able to draw the expansion line which would be produced if the steam in the cylinder was always saturated and did not vary in weight. The curve calculated by Zeuner is practically of the form $p\,v$,

$$p\,v^n = \text{constant},$$

the value of n in the formula being 1,06462.

Fortunately Messrs. Fairbairn and Tate have given us experimental results which confirm as closely as could be expected the calculated results of Rankine and Zeuner. A curve representieg the experiments of Fairbairn and Tate has been plotted according to their empirical formula.

$$v = 25.62 + \frac{49.513}{p + 072};$$

in which v is the volume of the steam, and p the total pressure in inches of mercury.

By comparing this curve with Mariotte's, we see that, commencing to expand with the same pressure and volume, the pressures belonging to the former fall below those belonging to the latter. This shows the inconsistency of De Pambour's belief that the curve of Mariotte was also the curve of a constant weight of saturated steam. We may consider Fairbairn's curve to be an important departure from the curve of Mariotte. I have calculated the value of n for this curve on the supposition that it is of the form $p\,v^n = \text{constant}$, and I find that the facts cannot be exactly expressed by that formula.

Count Rumford was the first to determine experimentally the mechanical equivalent of heat. Professor Tate has deduced from the results of his experiments a value for that equivalent which is but about twenty per cent. too great, a remarkable result considering the knowledge of his time. The credit for having determined the now universally accepted value of the mechanical equivalent of heat— *i. e.*, 772 ft. lbs. —is due to Dr. Joule.

Shortly after the announcement of Joule's experimental determinations, Rankine and Clausius drew from it and from Regnaults's experiments, by a mathematical process, a very interesting conclusion. They found that if no heat were communicated to the steam during the expansion, the steam would be obliged to give up heat in order to produce the work done during the expansion. In other words, some of the steam would be condensed while the steam was expanding, and instead of the expansion line being a curve of a *constant* weight of saturated vapor, they believed it to be a curve of a *constantly decreasing* weight of vapor. Rankine called this an Adiabatic curve. Zeuner says of this discovery that it is, without doubt, one of the most remarkable to which the mechanical theory of heat has led. He says further that it is time that the old theory of steam engines should be replaced by a new one.

Rankine gave the following approximate formula for this Adiabatic curve.

$$p\,v^n = \text{constant}.$$

He gave for the value of n in this formula ten ninths or 1.111. The high reputation which has attached to Rankine in this country has led many practical, as well as scientific men to take it for granted, witnout proper examination, that this Adiabatic line is the line along which steam should expand in a theoretically perfect engine. No doubt the mathematical entanglement which surrounds the subject has hindered many persons from getting at the "rationale" of it. They have accepted it without knowing what they were doing.

Zeuner, as the result of an interesting mathematical process, concludes that, if he has dry saturated steam at the beginning of the expansion, he will have different values of n, according to whether the steam is expanded much or little; but beginnining to expand with dry saturated steam, the value, 1.135, is near enough to the truth for practical purposes. He concludes further that if, at the beginning of the expansion, the steam was mixed with .10 of water by weight, n would equal 1.125; if .20 of water by weight, n would equal 1.115; if .30 of water by weight n would equal 1.105.

Before going further I should like to have you recall two important points in what I have said. De Pambour and his followers believed that the theoretically correct expansion line for steam in a cylinder was a Mariotte curve, and that this curve was also the curve of a constant weight of saturated steam. Rankine, Clausius and Zeuner give the Adiabatic curve instead of Mariotte's curve, and the scientific world has generally accepted this curve as coming nearest to the curve according to which steam should expand in the cylinder of an engine.

It is supposed that the steam neither received heat from, nor imparts heat to, any other substance during the expansion, but that as much heat as is necessary for the purpose is converted into the work done during expansion. The heat converted into this work is then obtained from the steam which is expanding, and a portion of it is therefore condensed, and the curve is one of a decreasing quantity of saturated vapor.

I now venture to state that accurate and interesting as the mathematical process by which the nature of the Adiabatic curve has become known it is still by no means certain that steam in a cylinder should be expected to expand along an Adiabatic curve. The supposition that the steam neither receives heat from, nor imparts heat to, any other substance during the expansion, is an untenable one, and the conclusion is in error to the extent that it is affected by this supposition.

Both scientific and practical men are deeply indebted to Rankine, Clausius and Zeuner for the light which they have thrown upon intricate questions of thermodynamics. But when it was known that the steam in a cylinder would expand along an Adiabatic curve only in case no heat, as heat, should be added to or subtracted from the steam during the process, it should not have been concluded so hastily that steam expanding in the cylinder of an ordinary engine conformed to this condition. If it was difficult to observe directly the temperature of the steam in the cylinder for the purpose of proving whether this premise was correct, we should have compared the Adiabatic curve with the expansion curve of numerous indicator diagrams, for the purpose of verifying the conclusions. If the indicator curves agreed with the Adiabatic curve we should grow more confident that the ordinary conditions were those of the Adiabatic curve; but if we found divergence instead of agreement we should form a different opinion.

I have said that the Adiabatic curve is a curve of a *constantly decreasing* weight of steam, whose nature can be expressed by the formula

$$p\,v^n = \text{constant},$$

in which $n = 1.135$, if the steam be dry at the beginning of the expansion;—that the curve of a *constant* weight of steam can be approximately expressed by the same formula, if the value of n be reduced to 1.0646; and I have practically said that Mariotte's curve can be expressed by the same formula, if the value of n be still further reduced to unity. It is readily seen that Mariotte's curve is a curve of a *constantly increasing* weight of steam, and, generally that the smaller the exponent n in the formula, the more rapid is the increase in the weight of steam during the expansion.

I now propose to lay before you a few of the facts which have led me to believe that the conditions of ordinary expansion are not those of the Adiabatic curve, and that engineers made progress backwards when they substituted the Adiabatic curve for that of Mariotte, as the curve according to which steam should expand in a cylinder.

Every engineer who has had much practical experience in the application of the indicator will agree with me if I say that, in almost all cases, diagrams taken from unjacketed engines using saturated steam expansively, show a *greater increase* in the weight of steam during expansion, than if the steam had expanded along a Mariotte's curve. This appears from the fact that, when a Mariotte's curve is drawn through the point of release, it almost always lies wholly above the expansion line During the winter of 1874-5, I suggested to Mr. James H. Head, then a student of the Institute, that he examine the expansion curves of various indicator diagrams. The results of his examination will be best understood through the following abstract of his graduating thesis:

"Professor Rankine states that the coefficient of expansion of dry saturated steam in an unjacketed cylinder is $\frac{10}{9}$, and in a jacketed cylinder $\frac{17}{16}$. That is,

$$p\,v^{\frac{10}{9}} = \text{constant, and } p\,v^{\frac{17}{16}} = \text{constant.}$$

where p represents the absolute pressure and v the volume of the steam. These values of the coefficient were determined by calculations which were based on theoretical deductions from the known nature of steam and work; but they were not determined by direct experiment. The purpose of this investigation was to ascertain whether the values calculated by Rankine agreed with the results of direct experiment with ordinary steam in ordinary engines, for it was believed that the effect of an important influence was overlooked in his calculations. Twenty-five or thirty sets of indicator cards taken from different engines having unjacketed cylinders were obtained for examination. Generally, saturated, but sometimes superheated, steam was used. No data were obtained from jacketed cylinders.

"As far as this investigation goes, it appears to be true that the coefficient of expansion given by Rankine for unjacketed cylinders is incorrect for practical usage, For, first—The law expressing the relation of pressure to volume, when either saturated or superheated steam is expanding in an ordinary unjacketed steam cylinder is not necessarily of the form $p\,v^n = \text{constant}$. Only in the case of one or two expansion curves could the relation be expressed by that form and approximate closely to the truth.

"Second—On expressing the relation approximately by the form $p\,v^n = \text{constant}$, I find that the coefficient n is not constant; that it varies in different engines, and even in the same engine, if the point of cut off be changed. In the case which I examined, I found it to vary from .65625 to 1.0200. These extreme coefficients were both derived from saturated steam diagrams taken from the front end of the Harris—Corliss engine in the mathematical laboratory of the Massachusetts Institute of Technology. Its cylinder is 8.01" in diameter and its stroke 24". The coefficient .65625 was derived from diagrams taken with an apparent cut off of $\frac{1.}{18}$. The steam pressure was 71 lbs. per square. The speed of the engine was 57 revolutions per minute. The coefficient 1.0200 was derived from diagrams taken with a real cut off of about ¾. The steam pressure was 70 lbs. per square inch. The speed of the engine was about 59 revolutions per minute."

Two principal reasons have been assigned for the increase in the weight of steam in the cylinder during expansion.

First—Leakage of steam. Second—The re-evaporation of water which entered the cylinder as steam and condensed against its cool walls during the early part of the stroke, the re-evaporation being produced by heat returned to the steam during expansion by the walls of the cylinder. It seems to me to be a reasonable supposition that the leakage past the piston packing and the exhaust valve should at least equal the leakage past the steam valve in most cases. In other words, it seems reasonable to suppose that in most cases at least as much steam will leak out of, as into the cylinder, during the expansion.

There are many reasons why I think it more likely that the results are rather due to condensation and re-evaporation. I cannot help suspecting that speculative thinkers are indirectly responsible for some of the blunders in engineering which are made by their disciples, and which cost the public hundreds of thousands of dollars annually. I think that had the schools paid more attention to the study of the *facts* which relate to the *economics* of steam engineering, less coal would have been burned per annum in the production of power, and less capital would have been invested in expensive engines.

MICROMETER OR STADIA.

BY JOHN NEWMAN, C. E., MANSFIELD, OHIO.

(Written for Engineering News.)

Micrometer or Stadia has long been used in astronomy and has given a degree of precision that could not be attained by divided circles.

Of the several methods of constructing micrometer or stadia, for the measurement of terrestial distance, we consider the one formed in the focus of a telescope, by stretching two hairs across the diaphragm a known distance apart, to be the most accurate and by far the most convenient, of any of the forms now in use.

The method now generally employed is to place the hairs on the ring horizontal; the rod is then held vertical.

If the hairs are placed vertical on the ring, then the rod is held horizontal, and this method will be found on trial, to be the most convenient. Suppose we wished to measure four thousand feet; this would require the rod to be forty feet long, and would not be practical. But if the hairs are vertical the range poles can be set on each side, so that the centre of each is in position; a measurement with an accurate tape line, will give the distance with precision.

This is not only the best position for a long range, but it is the best and most accurate for a short one; for the rod can be laid on the top of a stake, driven in the ground so as to be as high as the line of sight of the instrument; or a tripod can be used for this purpose, which will enable the assistant to bring the rod at right angles to the centre line of sight, a position required for accuracy in all observations with stadia for the measurment of distances, as we shall fully show, when we come to discuss the optical principles involved.

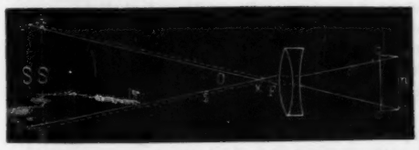
The theory is the same, whether the hairs are put on the ring horizontal or vertical: for this reason we shall omit any further argument on this part of the subject.

A good telescope, having the hairs arranged vertically in the focus, as above described, is theoretically and practically, the best instrument for measureing distances without tape or chain, that the practical surveyor, and civil engineer, can now command.

The optical principles involved in this simple instrument, are very singular and elegant.

In our optical illustrations, we will use the same notation that Potter has used in his optics.

The diagram is not intended to be accurate; it is simply for illustration.



In the diagram, *o* called the *centre of the lens*, where the full line from A and B meet at *x*, the focal centre of the first surface, and where the dotted lines meet at F, the focal centre of the last surface.

In all object glasses having the meniscus form, their centres are a little in front of the lens, as shown by the diagram; they are determined from the thickness of the lens and radii of the first and last surfaces.

It is demonstrated in optics, that a ray of light from B, for instance, meeting the first surface of the lens, as in the figure, would be bent by the refraction of the lens downwards, so as to change its course while passing through the lens; if this course projected backward passes through *o*, the optical centre, then the emergent ray will be parallel to the incident ray; as shown by the dotted lines in the diagram, and causes the diagram to appear as viewed from a point *nearer* to the lens than its real position.

Let the size of the object A B, equal *s*, the distance of A or A′, from the focal centre, X or F, of the object glass equal *u*, the distance of a point in the conjugate image *a* or *a* from F, equal *v*, the size of the conjugate image of the object *a a*, equal *n*, which is the distance apart of the stadia hairs; the stellar focus of the object glass equal *f*.

The formulae connecting the conjugate foci, is, by Patter's Optics, $\frac{1}{v}=\frac{1}{f}-\frac{1}{u}$. (1)

In equation (1) f is constant while u and v are variable.

The similar isoceles triangles A′ B′ F *a a* F, give the equation $\frac{u}{v}=\frac{s}{n}$ (2), multiply both sides of equation (2), multiply both sides of equation (1) by u, and $\frac{u}{v}=\frac{u}{f}-1$, substitute this value of $\frac{u}{v}$ in (2) and we have $\frac{u}{f}-1=\frac{s}{n}$; solving this equation gives the value of $u=\frac{f}{n}s+f$. (3).

To show the practical use of this equation and demonstrate its accuracy, we have calculated the following table; giving to u, in equation (1) values varying by 100 feet, and f a constant value equal to 0.5 feet, which is about the stellar focus of most transit telescopes:

U.	*V.*
100.5	0.5025
200.5	0.50125
300.5	0.500833⅓
400.5	0.500625
500.5	0.5005
600.5	0.500416⅔
700.5	0.50035 5/6
800.5	0.5003125
900.5	0.5002 7/9
1000.5	0.50025
2000.5	0.500125
3000.5	0.500083⅓
4000.5	0.500063¼

Equation (3) is the foundation for all measurements made with the above described micrometer or stadia.

What does it direct us to do? How shall we use it? What point does it direct us to measure from?

We will illustrate its use by an example; to adjust the stadia hairs, so that they will just cover one foot on the rod, for every 100 feet of distance; measured from same point given by equation (3).

Any other distance could be repeated in the same way but 100 is evidently the most convenient.

Set up a correct foot measure so as to be 100 feet *plus the stellar focus f*, from the focal centre F, and extreme points A and B of the rod; which in our example is A F =B F=100.5 feet, the first value of u in the table, and make the hairs by their adjusting screws just cover s, one foot on the measure.

This is the only position of the measure that will bring the image at right angle to the optical axes of the telescope, in which position only it can be actually measured by the stadia hairs.

Now we have $u=100.5$, $s=1$, $f=0.5$, substitute these values in equation (3), and we have $100.5=\frac{0.5}{n}+0.5$, substitute 0.5 from both sides of this equation and $\frac{0.5}{n}=100$, or $n=\frac{1}{200}$.

This value of n is a constant determined once for all.

By inspecting the diagram and table it will be seen that as the rod recedes from 100.5 feet to 1000.5 feet from the focal centre F, of the object glass; the stadia hairs move from *a a* to *c c*, and as their distance is now constant and equal to n, the angle of the triangles at the crossing of the lines B *a* and A *a*, will vary, as is easily seen from the figure, by conceiving lines drawn from *c* and *c* to F which are omitted in the diagram to avoid confusion; but these triangles will always be similar.

The value of $n=\frac{1}{200}$ is the base, and the value of v, in the table is the sides of the *variable optic triangle a a* F; while the value of u and the space s, covered on the rod is the sides and base of the *variable geometric triangle* A′ B′ F, or its equal A B X.

With the instrument now in complete adjustment *for all distances;* suppose the rodman has receded from the focal centre of the object glass until the stadia hairs just cover 5 feet on the rod held so as to be at right angles to the optical axis of the telescope; what is his distance from the focal centre of the object glass?

The similar triangles A B X, or its equal A′ B′ F, and *a a* F, taken from our table gives the proportion,

$$\frac{1}{200} : 0.5005 :: 5 : 500.5$$

Until the hairs covers 10 feet on the rod, the triangles give $\frac{1}{200} : 0.50025 :: 10 : 1000.5$

Until the hairs cover 20 feet on the rod, the triangles give $\frac{1}{200} : 0.500125 :: 20 : 2000.5$

Until the hairs cover 30 feet on the rod, the triangles give $\frac{1}{200} : 0.500083\frac{1}{3} :: 30 : 4000.5$

Until the hairs cover 40 feet on the rod, the triangles give $\frac{1}{200} : 0.500063\frac{1}{4} :: 40 : 4000.5$

The above proportions show that the optical constant f, is a part of every stadia measurement, and its introduction in equation (3), elegantly compensates for the change in the angle of the triangles at every move of the rod, and renders the measurements for any distance as complete and accurate as any proposition of Euclid.

It is now clear that the measurement actually begins as far in front of the focal centre F, as the stellar focus f of the object glass; that in order to measure the distance R S we must place the focal centre F, of the object glass as far behind R as its stellar focus f.

The stellar focus may be found by pointing the telescope to a star, and focusing, then measure from the cross hairs to the front of the object glass; which is accurate enough for all practical purposes.

In the measurement of distance with stadia, the rod must be held at a right angle to the optical axis of the telescope *in all situations;* whether at an elevation, depression or horizontal.

If held at an elevation or depression, the distance given by the stadia, is reduced to the horizontal distance by multiplying it by the cosine of the angle of elevation or depression.

The idea of holding the rod vertical on the top of a high hill and then multiply the reading of the rod by the square of the cosine of the angle of elevation, to reduce it to the horizontal reading is certainly absurd; for the reason that the rod in this position, would be very oblique to the optical axes of the telescope, and we know from optics, that its image would have the same obliquity, and could neither be brought in correct focus at its extreme ends at the same time, nor be accurately measured by the stadia hairs since they were adjusted to an image at right angles to the optical axes or line of sight.

The difference in distance measured along B F or F S, is equal to a unit diminished by the cosine of half the angle A′ F B′ multiplied by the distance F B.

The angle A′ F B′ is variable, its half will average about 18 minutes, therefore A F (1−cos. 18′=difference =B F(1−0.9999862922)=B F×0.0000137078; take B F =4000 feet, then the difference equals 0.0548312 feet, or a little less than two-thirds of an inch in four thousand feet, so that we may for all practical purposes take B F or S F, without any material error.

With a telescope perfectly achromatic and aplanatic, equation (1) could be used to measure distances without any stadia hairs or rod, provided we could measure the exact distance from the focal centre to the cross hairs, when in focus on the object observed.

Suppose we have focused such a telescope on a distant object, and find by accurate measurement that $v=0.500005$ feet, what is the distance to the object observed?

By equation (1) we have $\frac{1}{0.50000}=\frac{1}{0.5}-\frac{1}{u}$ which by reduction gives the value of $u=50000.5$, the distance required.

In this result we find the *optical constant again;* the object would be fifty thousand feet from the measuring point, or nearly nine and one-half miles.

A telescope could be arranged with a fine screw and graduated head for focussing that would measure the focal distance F $a=v$ sufficiently accurate, that equation (3) would give the distance to a sufficient degree of approximation for most military purposes.

Having fully presented the theory, we will now give the best practical method of adjusting the hairs.

Choose a level piece of ground and set from four to six stakes in line, one hundred feet apart, from a point marked on each stake, as the power of the telescope will command, numbering them 1, 2, 3, 4, 5, and 6. Place the telescope so that the front surface of the object glass is as far behind the point on the first stake, as its stellar focus, which makes the distances measured correspond to the values of u in the table.

Having the telescope now in position, adjust the stadia hairs to cover one foot on the rod, held on the second stake at right angle to the line of sight, two feet on the third stake, three feet on the fourth stake, four feet on the fifth stake, and five feet on the sixth stake, making the whole agree as nearly as possible; which will give the best practical adjustment that can be made.

Lieut. Ruffener, Chief Engineer of the Department of the Missouri, departed from Ft. Leavenworth last Tuesday morning, with an expedition numbering one hundred men, for the Pan-handle and Red river country in Texas, for the purpose of surveying that region. They will equip at Ft. Dodge on their way.

ENGINEERING NEWS.

SATURDAY, APRIL 29th, 1876.

GEO. H. FROST, - Editor and Publisher.

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and of the

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Note change of address, 153 Washington St.

Civil Engineers' Club of the Northwest.

CHICAGO, April 25th, 1876.

The May meeting will be held at the Sherman House Club Rooms, at 4 P. M., Tuesday, May 2d. Subject for discussion, "*Adoption of the Metric System.*" L. P. MOREHOUSE, Sec.

TECHNICAL EDUCATION.

In continuation of our remarks of last week, let us take the following case:

A young man of fair education, persuaded that he desires to become an engineer, or attracted by the operations of a field-party, seeks and obtains a position upon a railroad location. He is diligent and apt to learn, gradually acquires some knowledge of the use of instruments, from the instruction of the assistant with whom he is connected, and is, after a time, promoted from chainman and rodman to leveler or transit-man. He knows how to run a line of levels, to put in a circular curve, to cross-section and stake out work, and he is finally put in charge of a section under construction. He can satisfactorily go through with the round of duties assigned to him, doing everything in the routine way in which he has been taught to proceed, and able to look after such work as he has seen before. In short, he has become a good field assistant. If work is plenty he continues in very much the same path for years; he is likely to be too much engrossed with his daily duties to find much time for connected study, and, in the little time available, bodily weariness hinders close application. The absence of one competent to explain difficult points and who has the leisure to attend to him is then strongly felt. Few will give up work for the sake of turning to study, but will postpone the attempt at improvement until a duller season. If work is lacking, in many cases the immediate incentive to study is wanting.

The above case represents that of some young men whom we have known; they either continue as division engineers for an indefinite period, or finally, becoming discouraged at the poor prospect for advancement, turn their attention to something else. In other cases, where a decided effort to study has been made, the young engineer has found himself deficient or rusty in branches preliminary to those which he wished to take up, and has either worked alone at a disadvantage or has been obliged to review his elementary mathematics and such branches again.

Now and then we find an engineer who became aware of his deficiencies, who wished to remove them and to advance in his profession, and who resolutely devoted a sufficient time and a portion of his savings to a course in a technical school. Such an one commonly turns out well. But some of the others would have made engineers equally as good, if their efforts had not been misdirected, and they had received the right kind of encouragement, It is complained that there are many reputed engineers of too limited knowledge and too large pretensions. It seems to us that the facility with which a superficial knowledge of common engineering operations may be acquired and existing structures may be copied is the reason for this state of things. The quasi engineer launches out with a small stock of information and never afterwards makes any determined effort towards improvement.

The preferable course in our judgment is that, after as generous a general education as may be possible, the student who proposes to become a Civil Engineer shall pass easily from the high school or college to the technical school, with his knowledge of preliminary branches fresh, and his habits of application to books unimpaired, and we think that, after a good course of theory, with as much practice as the school can afford, he will soon be able to overtake one who has pursued the opposite plan. Allotting to each the same time, three years of work after graduation will put him in advance of the man who took his work first and his technical studies second.

We are also inclined to object to those who urge the gaining acquaintance with the practical part of a *specialty* first, and then the study of that branch in a technical school under a specialist later, that the young man is hardly prepared to decide what branch of the profession he should prefer or be best adapted for, until he gains something of a general view of the whole. He might have an opportunity, as a novice, or, from what he had heard, he might think he would like to join a railroad party, such as we described above, or to go into a city engineer's office, or to get a situation in some bridge works, or on hydraulic works, or the lake survey, or on river improvements or some other branch of professional work; he knows little or nothing of any field of labor but the one he chooses and, after two or three years of field and office work, he goes to a technical school and takes up that particular branch of study. Three chances to one that sooner or later he, having gained enough acquaintance with other specialties to form an opinion, regrets his choice, at a time when a change will involve different and further preparation. To be sure there are many points of similarity in the different engineering branches, but there are other points of dissimilarity, and one can not readily change from a specialist in one branch to a specialist in any other. Understand that we are referring to the argument of those who wish to train up *experts* and specialists, by work and practice first and then study in one particular direction later.

This seems to us to be just the way to educate men in a rut, to make them more machine-like, so that they know admirably well how to do one particular line of work, and to stunt them in height and breadth. As it is now, a student pursuing an engineering course takes up all the general studies which pertain to his profession, as well as others which, while kindred, are not so essential, he is taught the special application of the principles to each branch and puts them in practice as far as possible, he is drilled in the higher mathematics, he lays a broad and sure foundation, and, as he progresses in his course, he is able, from an impartial stand-point, to select that field of labor which seems to him most desirable. Where no predilection is felt the student naturally takes the employment which offers, and we have heard it said, by those who have observed, that scarcely any engineer has finally settled down into that department which they at first thought of undertaking. Circumstances exercise a predominant influence over a man's life.

We are rather surprised to find that one writer thinks the higher mathematics may well be dispensed with. While most problems may be solved in what may be called an elementary way, there are many cases where the simpler way is the longer, and there are some investigations that only yield definite answers when attacked by the calculus. This is a method of analysis in which one soon loses dexterity from disuse, but the results which we have once obtained or verified we can afterwards put confidence in, even if we can hardly deduce them *de novo*. Besides, the argument might be as legitimately offered that a knowledge of German and French is unimportant because we can obtain most of the valuable books and papers in translations from those tongues. It is a trusting to some one else's assurance that certain results are right. If we are not able to integrate a function with ease, it does not follow that the knowledge of the higher mathematics will not enable us to read understandingly and with profit many productions of engineers in our own tongue.

One other point on which we would remark is the establishment of facilities for experimental research. A laboratory or workshop, where the students can test the theoretical and empirical formulæ of strength and resistance of materials on a reasonable scale is an excellent adjunct. The work there serves to fix principles deeply in the mind. Opportunities are afforded, at a moderate and sometimes at no expense to the student, to experiment upon different materials of construction and upon models; the apparatus he could not procure for himself without great expense. The best American schools are vieing with each other in this direction. The only trouble is to find the time in an already crowded course of study to devote to laboratory work. American youth are so desirous of getting on, that it will be difficult to lengthen the time of study, unless all good schools take the step together.

RAILWAY RESISTANCE.

Recently so many important facts have been developed by the experiments made with the dynagraph to ascertain the causes of railway resistances, which so largely affect the cost of transportation, not only to railway companies, but to the entire community, that engineers and railroad officers, who are acquainted with the results already obtained, deem it of the greatest importance to the interests of *cheap transportation* that a series of exhaustive experiments be made upon engines, cars and trains to ascertain the amount of power required to overcome their friction upon all kinds of track. So rapid has been the progress of railway construction until recently, that time has not been taken to investigate really the fundamental principles of what should constitute a railway for cheap transportation.

Already by the great liberality of the Lake Shore & Michigan Southern R'y Co., many investigations have been made over their line and also some upon the Cleve- & Pittsburgh, and the Atlantic & Great Western R'ys. To carry on these experiments already inaugurated, all the railway companies will be solicited to aid and assist. At the present time facts can be given them of more value than the aid they will be asked to contribute. Upon one railway, it is not generally possible to find all the conditions which occur in transportation, so that conclusions drawn from experiments upon one road would only be true of any other railway using the same motive power, the other conditions being the same.

As an example, the power required to draw a train of 709 tons upon the Lake Shore & Michigan Southern R'y, from Cleveland to Erie, 95½ miles, was equivalent to 2,448,940,340 foot lbs., (by the foot lb. is understood the power required to raise one lb. one foot high), using 8,670 lbs. of coal; each lb. of coal yielding 273,319 foot lbs., utilizing only three per cent. of the theoretical power which the chemical composition of the coal would indicate in moving the train.

On the Cleveland & Pittsburgh R'y the power required to draw a train of 313 tons from Cleveland to Wellsville, 99 miles, was 1,754,556,400 ft. lbs., using 4,400 lbs. of coal, each lb. of coal yielding 398,763 ft. lbs., utilizing in moving the train, 4½ per cent. of the theoretical power of the coal. Taking the average resistance for each ton per foot upon the L. S. & M. S. R'y it was 6.85 lbs., and upon the C. & P. R'y it is 10.72 lbs., owing to heavier grades, sharper curvatures and an iron track which is far from being smooth, and the car construction is somewhat different. Take the usual method of computing the work done by the amount of tonnage hauled one mile per lb, of coal, and on the L. S. & M. S. R,y it is 7.56 mills, and on the C & P R'y 7.04 mills, a difference which would be readily attributed to its 40 ft. grades, while those upon the L. S. & M. S. R'y do not exceed 17 ft. on the Erie division.

Taking the last method of computation with such close apparent results and the conclusion would likely be that the motive power of each railway was operated with equal economy.

On the C. & P. R'y the resistance per ton is 57 per cent. greater than upon the L. S. & M. S. R'y, yet the effect produced per lb. of coal on the former is 50 per

cent. greater than on the latter. The comparison shows that the effect of the fine steel track of the L. S. & M. S. R'y is in a great measure offset by the better adaptation of motive power upon the C. & P. R'y; therefore as far as the cost of transportation is concerned the cost upon each road could be lessened by each adopting the better principles of other roads. These results were taken from the experiments made, and are as likely to be under as over the ordinary average. It is not expected that the heavier grades of the C. & P. R'y can be operated as cheaply as the lighter ones of the L. S & M. S. R'y. This shows that if we wish to arrive at facts we must take into consideration all the attending circumstances. It was also found that with the heavy trains of the L. S. & M. S. R'y that a speed of 18 to 20 miles per hour required less fuel than a speed of 10 to 12 miles per hour. It remains to be investigated with the steel rail and good road bed whether the destruction of the track is greater than at the slower speeds.

It was found that the construction of the journals and trusses, and the kind of lubricant used affected largely the amount of friction of the axles. In Mr. Dudley's experiments upon Heat and Combustion, he found by actual use upon the C. & P. R'y that a saving of 10 to 16 per cent. more of the heat could be utilized by a proper admission of air by avoiding the great excess which is usually drawn into the fire boxes by the sharp exhaust. It is by saving in apparently small things that an economy in transportation is effected.

Many experiments have been made with single cars, the results of which are now being calculated. Nearly 4000 miles of diagrams have been taken, most of them of great value; but before final conclusions are reached diagrams are needed under all the varying conditions of transportation.

Mr. Dudley started from Cleveland the 13th inst. on a freight train, over the L. S. & M. S. R'y, and arrived in Chicago the 14th inst. taking a diagram of the power required to draw the train the entire distance. He now has diagrams of the power to draw trains from Buffalo to Chicago. He left on a stock train for Cleveland the 17th inst.

WEBSTER'S UNABRIDGED ILLUSTRATED.—Viewed as a whole, we are confident that no other living language has a dictionary which so fully and faithfully sets forth its present condition as this last edition of Webster does that of our written and spoken English tongue.—*Harper's Weekly.*

Personal.

A. S. Gurnee has been appointed Chief Engineer and Superintendent of Water Works in Lake View, adjoining Chicago.

C. M. Higginson was recently appointed Purchasing and Supply Agent for the C. B. & Q. R. R., with headquarters in Chicago.

John W. Garrett. President of the Baltimore & Ohio Railroad, passed through Chicago enroute to California, on Tuesday evening.

Seth E. Marsh, C. E., of Hartford, Conn., is President and Chief Engineer of the Board of Water Commissioners, and also State Engineer.

Col, J. M. Leighton, of the Leighton Bridge & Iron Works, of Rochester, N. Y., was in this city last week attending to the western interests of that company.

Marvin Hughitt, Esq., has been appointed General Manager of the Chicago & North Western R. R. vice H. H. Porter, resigned. An entire change in the management of this railway is expected to take place in June next.

C. H. Bunce, Civil Engineer, was elected City Surveyor of Hartford, Conn, on the 18th instant by the Board of Common Council. Mr. Bunce had three majority over H. G. Loomis, the present incumbent, He was formerly engineer on the Conn Valley R. R., and was City Surveyor some years ago. He is an engineer of ability, and will no doubt discharge his duties satisfactorily to the public.

Manufacturers' Intelligence.

The Keene, N. H., mills and shops are doing about the same as last year.

At Claremont, N. H., most of the mills are running on full time, and the business outlook is better than last year.

The Joseph H. Brown Iron & Steel Company, of Chicago, has increased its capital stock to $500,000, a certificate of which was filed with the Secretary of State at Springfield, last Tuesday.

The Leighton Bridge & Iron Works, of Rochester, N. Y., have contracts ahead for over thirty iron bridges, of which a considerable number are for the Boston & Albany R. R. Co. and the Delaware, Lackawanna & Western R. R. Co. These works are now employing about one hundred men on full time.

The Geo. F. Blake Manufacturing Co., of Boston, have closed up their branch establishment in this city and transferred their accounts and business to the well-known house of C. L. Rice & Co., 215 and 217 Lake St., Chicago, who will in the future represent the company in this market.

The business outlook for the Fall River, Mass., manufacturers grows more encouraging every day it is claimed. American cottons continue to meet with increased favor in the English markets, and over 20,000 pieces of print cloth are shipped weekly to Manchester. The King Phillip mills have just received orders to send 2,000 pieces of sheeting, per week, to the Manchester house of H. B. Claflin & Co., of New York, and there is every prospect that this export will be enlarged.

CORRESPONDENCE.

EDITOR NEWS—Please say for the benefit of S. Pettibone and others, that the measuring off of 40 acres per Government survey, is a supposed requirement and which is perfectly legitimate, and besides was an actual fact. Wherefore, in such a case, and under the conditions stated, I would like to hear what objections can be preferred against my method of accomplishing that end.

A. J. PIERCE.

MR. EDITOR:—The north boundary of Sec. 36, T. 49 north, R. 7 west 5th P. M. is given in the Gov. Field Notes at 84.94 chains; the north boundary of Sec. 35, 83.89 chains, the sum of the two 169.83 chains; the south boundary of the two, 160 chains of course. The south boundary of Sec. 1. T. 48, R. 9, is 79.25 chains, of Sec. 2, 80.32 chains; the sum 159.57 chains; difference between the north boundary of Sec. 35 and 36, and south boundary of Secs. 1 and 2, 9.29 chains. The bearing of range line is north 13′ east, and bearing of line between Secs. 34 and 25, north 1° west. Any disparity in the north and south boundaries of Secs. 35 and 36 is made up in the gain over the Gov. measure on the township line. The ¼ Sec. corner between Secs. 10 and 11, T. 48 R. 7, has witness trees standing and a "line tree" at 21.42 chains north of that corner is also standing. No other evidence between that and the township line, and none there. The bearing of that line through township, intersects the township line 730 links east of the corner of Secs. 34 and 35, T. 49, R. 7, which corresponds with the other lines and measurements. But the Gov. notes make the point of intersection, or rather gives the falling at .50 links. The area of the north-west ¼ of Sec. 2. was calculated and sold by that falling, and also the north-east ¼ of Sec. 3. There was evidently a mistake in the Field Notes. Will you, or some of my brother County Surveyors, or both, say which is the proper place for the corner between Secs. 2 and 3 on the township line, the distance given in the notes or the point of intersection—and where this ¼ Sec. corner on the north line of Sec. 3, and where is the south-west corner of Sec. 2.

THOS. H. HOLLEY.

Fulton, Mo., April 26th.

ANS. Chain the township line, noting carefully and critically all evidences of original measurements; where none are to be found divide pro rata according to Government notes between well established measurements; the south corners of Sec 35 will necessarily be located by one or both of these methods and the north-west corner of Sec. 2 is to be placed fifty links, as per Government records, to the west of the established south-east corner of Sec. 35. The north ¼ corner of Sec. 34 can then be established according to the notes. The south-west corner Sec. 2 will be established by dividing the sections pro rata. We would never establish a line by the recorded bearing if there were any other way to do it.

The Common Council of the city of Peru, Ill., have resolved to burn no more gas for the illumination of the streets, at $4 per 1,000 feet.

Railroad News.

The Railroad Commissioners of Connecticut are making their semi-annual examination of the railroads of the state.

The Ashland (Wis.) *Press* says that seventeen villages have sprung up on the Wisconsin Central Railroad, between Stevens Point and Worcester within two years.

The Binghamton *Times* says: The workmen on the Delaware, Lackawanna & Western Railroad, who were out on a strike, have returned to work at the old wages, $1 per day.

The Connecticut Central Railroad Company are going to petition the legislature for power to build a new bridge across the Connecticut at Hartford. The company are now running their trains over Hartford, Providence & Fishkill R. R. bridge.

At Springfield, Ill., last week at a Master's sale the Pekin, Lincoln & Decatur Railroad was sold for a total debt of $1,196,401.60. There was only one bid, which was made by John T. Martin on behalf of a committee of the bondholders, and the property was struck off to him for $500,000, to be paid cash or bonds in hand.

No better evidence is needed of the readiness with which English capitalists will subscribe to the railways in America, if only satisfied that they will be honestly and fairly managed, and with a due regard to the interests of those who provide the capital, than the reception accorded to an issue of $1,000,000 five per cent mortgage bonds of the Illinois Central Railroad. The whole amount was promptly taken at ninety-six cents. The issue was made for the purpose of providing additional rolling stock and steel rails. The bonds are included in and form part of the consolidated mortgage of $15,000,000 under which, including the present amount, $11,000,000 has been raised.—*Indianapolis Journal.*

Fatty Water in Boilers, and the Proposed Remedy by Soda or Potash.

I will just mention a point of personal experience—in some starch works where caustic alkalis were used,—some of the caustic alkali water (although not strong) got into the boilers, they were unexpectedly found to throw very much less than the usual quantity of steam, and on urging the fire, the iron of the boilers heated, and "teats" were blown.

The boilers were obliged to be taken down, and opened, and we found a crust of an inch and a half in thickness of deposit formed where the water lay, it was a very hard and perfect stone,—of course the boilers were spoiled, and were replaced by new ones,—the boilers had been examined a week before, and no scale of any consequence found,—no doubt the water in the boilers was very "strong"—they were very quick boilers, made a great deal of steam, but contained but little water; they were blown out once a week.

A friend of the writer, connected with a steam mill, says the boilers formed a great deal of scale, and he cured it by putting "meat" into them. He often put in a whole quarter of inferior beef, and so long as the effect of the "soup" lasted, scales did not form on the boilers. But on attaching a distillery to the works, the meat had to be dispensed with, and the scale formed as before, which had to be removed by chipping and washing.

The cause of corrosion in boilers is not well understood. Some years since (a good many, in fact) a 30 horse power boiler of excellent construction corroded so that it had to be taken out, though comparatively new, and sold for old iron. The writer thinking the effect was "magnetic," purchased it and had it repaired. It was first placed in an unfavorable position and the corrosion continued, though on the outside. It was again removed and differently set and from that time never corroded. It was originally placed north and south, but eventually east and west. It was used in a saw mill for over 20 years and never cost a dollar for repairs, and is a good boiler yet. It was taken out and replaced by one of greater power, cut asunder, made into two, and is still at work.

We found a most complete cure for scale in the use of hemlock bark, it not only prevented the formation of scale but cleaned off what was already formed, so that the inside of the boilers was perfectly clean and black, and the deposits were loose mud, easily blown out. This may be depended on. E. L. C.

Contractors' Intelligence.

Ground was broken last week at Rockford, Ill. for the new court house.

The City Clerk of Indianapolis, has issued 262 building permits since the beginning of the year.

The indications are that more brick will be manufactured in Council Bluffs this spring and summer than ever before.

The Board of Public Works of Chicago issued an estimate of $3,736.66 to Cox Brothers last week, for work on the Blue Island avenue viaduct.

It is estimated that about three-fourths of the money paid out for street repairs goes into the pockets of a dozen or two self-constituted "bosses."—*Indianapolis Journal.*

The contract for the grading and masonry on the Springfield, Jackson & Pomeroy R. R. between Washington, C. H., and Bainbridge, Ohio, is let to I. N. Rucker, of Greenfield.

The Eastern gentlemen, to whom was awarded the contract for building the Marquette & Mackinaw railroad, have decided not to accept the same, and the work will have to be let again.

The stone to be used in the construction of the new court house at Sioux City will most likely be the Lamont, for cut stone, and either the Keosota or St. Joe for foot stone.—*Clinton (Iowa) Herald.*

The contract for the completion of the wings of the National Soldiers' Home at Milwaukee, Wis., was let, last week, to Sherburn Bryant, on his bid of $19,000. Quite a number of builders competed for the work.

All the "heavy" work on the West-Side pumping works was finished last week when the last working-beam was set up. The finer work on the engines and buildings will probaby be finished about the middle of June.

Work on the West New York and Brooklyn bridge is resumed, and will be continued day and night. It is expected that the stone work will be completed in about four months, and that the stretching of temporary cables will commence about the middle of August.

At Des Moines, Iowa, last Tuesday, ground was purchased at a cost of $11,000 on which to erect a $50,000 Exposition building, the contract for which will be let on Monday, May 8th. The building, which is to be 138x138 and three stories high, is to be completed by September 1st, 1876.

The contract for the Cass county, Ill., jail has been awarded to Mr. James F. Black, his bid being $14,000. He sub-let the brick and stone work to Mr. Hiram H. Pierce, of Peoria, the contractor who built the court house and the Farmers' National Bank building in Virginia. The building will be of brick resting on a foundation of Joliet rubble stone. It will be twenty-eight by forty feet in size, two stories high, with basement and will contain seven rooms.—*Jacksonville Journal.*

Bids for the building of the new Sixth street bridge over Eel river, at Logansport, Ind., were opened on Thursday the 20th inst, by the Board of Commissioners of Cass county. Twenty minutes were given to the explanation of each plan. Bids were received from eighteen different bridge building firms as follows; the prices attached being per foot:

Eureka Bridge & Iron Co., Chicago	$.....	$.....	$44.00	$27.00
Indianapolis Bridge Co. Indianapolis	.....	.....	.....	28.25
King Iron Bridge Co., Cleveland,	.....	.....	.....	30.50
Smith Bridge Co., Toledo,	31.95	32.40	33.90	34.90
Cincinnati Bridge Co., Cincinnati	.....	32.50	33.50	34.50
Massillon Bridge Co., Massillon, O.	32.95	35.00	36.00	37.40
Pennsylvania Bridge and Machine Works, New Breton, Pa	.....	.....	.....	33.00
McKay & Nelson, Ft. Wayne, Ind.	.....	.....	33.75	34.75
Detroit Bridge & Iron Works, Detroit	.....	.....	.....	33.90
Morrison, Field & Co.	.....	.....	34.50	37.00
Columbus Bridge Works, Dayton, O.	.....	.....	34.80	36.80
Keystone Bridge Co., Pittsburg, Pa.	.....	.....	34.85	36.85
Wrought Iron Bridge Co. Canton, O.	.....	.....	.....	36.00
Charles Graham, Cincinnati	$36.50	37.50	38.00	38.50	39.63
Milwaukee Bridge and Iron Works, Milwaukee	.....	.....	36.90	38.90
American Bridge Co., Chicago	.....	.....	.....	44.00
Louisville Bridge and Iron Works, Louisville	.....	.....	.....	53.00
Danville Wrought Iron and Wagon Works,	.....	.....	.....	45.00

The award was made by the Commissioners on Wednesday the 26th instant to the Massillon Bridge Co. at $35.00 per foot. The specifications call for a wrought iron truss bridge, two spans, one 122 and the other 110 feet in lenght. The bridge to be of one roadway twenty feet wide, and two foot ways each six feet wide.

Sea Waves as a Motive Power.

In our Review of Engineering for 1875, in No. 2 of the NEWS, we mentioned the proposed utilization of the force of sea waves as a motive power. A London journal of recent date contains an abstract of a paper read by Beauchamp Tower before a scientific gathering in England, descriptive of a machine for the purpose named: "It consists in principle," says the report, "of a weight supported on a spring, through a considerable range in a vertical line. The scale of the spring, and consequently the natural period of oscillation of the weight, can be varied at will. When it is so adjusted that it synchronizes with the waves, the oscillation becomes very violent, and a large amount of power can be obtained from them. In practice, the springs consist of highly compressed air pressing on the rims of hydro-pneumatic cylinders, and the arrangement is such that the vessel containing the compressed air forms the moving weights. The author exhibited a design of a machine for working an auxiliary propeller of a sailing ship of 1,800 tons displacement. The moving weight in this case is 200 tons, and he showed by calculation that it would give about 20-horse power in the long swell met with the tropical calms, 260-horse power in average ocean waves, and more than 600-horse power in a heavy head sea. The space occupied by the machine compares favorably with a steam-engine of the same power. The author exhibited a model of the machine, which recently, in a moderate sea, had yielded power at the rate of 1½-horse power per ton of moving weight."

PROPOSALS FOR CONTRACTS.

BRIDGE.—The Commissioners of Grant County, state of Indiana, will, on Friday, the 5th day of May, 1876 let the contract for the building of a bridge across the Mississinewa River at the point known as "Sutton's Ford." Plans and specifications on file in my office. By order of Board. Jos. W. Stout, *Auditor Grant Co.* Marion, Ill.

BRIDGE.—Proposals will be received at the office of the City Clerk of the city of Clinton, De Witt Co., Ills., up to 12 o'clock noon, on Wednesday, May 10, 1876, for the construction of a Howe Truss Iron Bridge across Ten-mile creek in that city. The bridge will have a span of forty feet, and twenty-four feet wide, including a five feet sidewalk and a double wagon road. Also, for the necessary stone work for the abutments of the bridge. Bids for the stone work will be at so much per yard. Plans and specifications can be seen at the Clerk's office. Wm. Bishop, Mayor, M. Donahue, City Clerk.

BRICK.—Proposals will be received at the office of the Superintendent of the U. S. Custom House and Post Office, Cincinnati, Ohio, until 12 M. of May 8th, 1876. for furnishing and delivering at the site of the United States Custom House and Post Office, Cincinnati, Ohio, one million (1,000,000) (more or less) hard burned red bricks, sound, and free from lime stones, of the best quality, taken from the heart of the kiln; no salmon, soft, or defective bricks of any kind will be received, and a sample of brick must be submitted with each proposal. Delivery must be made at such times and in such quantities as may be deemed necessary by the Superintendent. Payments will be made monthly, deducting ten per cent, until the final completion of the contract. Samuel Hannaford, Superintendent.

BRIDGE.—Bids will be received at the office of the Board of Selectmen, Room 2, City Hall, New Haven, Ct., until 7½ o'clock Thursday evening, May 4th, 1876, for furnishing the material and constructing an Iron Bridge of one span—100 feet between centers—40 feet roadway in the clear, with a sidewalk on one side 6 feet in the clear, over West river, at the Congress avenue crossing. For the purpose of inviting proposals from iron manufactures and others who have no plans of their own, plans have been prepared for a standard bridge. Bridge companies and contractors may bid on the engiuer's plan, or on plans of their own of equal strength and stiffness. Blank forms of proposals, with the necessary bond attached, and any information concerning plans, specifications, etc., will be furnished upon application. No proposals will be received after the time specified, and all proposals that arn not properly filled out will be rejected. The right to reject any or all bids will be reserved. Samuel Johnson, Secretary of Committee of Selectmen of New Haven and Orange.

CHURCH.—Bids will be received at the German Lutheran parsonage, 213 High street, Akron, O., until 12 m., May 8, for furnishing material and constructing a church edifice, complete in all respects in accordance with the plans and specifications. Plans and specifications may be seen and instructions given at the office of Mr. Frank Lukesh, in Cramer & May's Block, on and after April 17th, 1876. W. Hagemann, G. Haas, F. Manthey, Trustees of German Lutheran Church.

COUNTY BUILDING.—Proposals will be received until 12 o'clock, noon, on Thursday, May 11, 1876, at the County Farm House, situated on the southeast quarter section 13, township 48, range 32, for the erection of an additional building of the size and dimensions of the building already occupied as an asylum on said farm. Payment of same to be made in cash. W. Z. Hickman, County Clerk, Kansas City, Mo.

COURT HOUSE AND JAIL.—Proposals will be received by the County Commissioners of Sweetwater County, Wyoming Territory, at the County Clerk's office, Green River City, up to 1 o'clock, P. M., May 15th, 1876, for the furnishing of material and building of a Court House and Jail at Green River City, according to the plans and specifications which can be seen at the County Clerk's office at Green River City, Wyoming Territory. Bonds will be required in double the amount for the faithful performance of the contract. W. P. Noble, Chairman County Commissioners. A. McIntosh, County Clerk.

DREDGING.—The Board of Improvements will receive bids at Cleveland, O., until 12 o'clock M., May 15, for the necessary dredging and other labor in removing bars and obstruction, in the Cuyahoga River, between the Government Pier and Upper Central Way Bridge. Plans and specifications may be seen and blank proposals can be obtained at the office of the City Civil Engineer after May 1st. Each proposal must contain the full name of each person in and making the bid. No proposal will be entertained unless made on the blanks furnished be the engineer and no proposal will be accepted unless the party or parties making the same shall furnish evidence satisfactory to the Board, that they have the necessary machinery, experience, energy and ability for doing the work, is trustworthy, has sufficient pecuniary resources and is prepared to commence the work within five days after the contract is approved by the council. A bond of $2,000, with surety to be approved by the Board must accompany each proposal that in case the proposal is accepted a contract will be entered into within eight days after the award is made. The right is reserved on the part of the Board, to reject any or all proposals not in accordance with the conditions of this advertisement or that do not conform with the specifications furnished by the engineer. B. F. Morse, City Civil Engineer.

GAS FIXTURES AND HARDWARE.—Proposals will be received by the Commissioners of Construction of the Central Ohio Hospital for Insane, until 12 o'clock noon, Thursday, May 11, 1876, for the Gas Fixtures for the entire building, and Locks, Bolts and Latches, for eight wings of Asylum building. Plans, specifications and blanks are now on file at the office of the Architect upon the Asylum grounds, for the inspection of bidders. All bids must be sealed and directed to Geo. W. Manypenny, Esq., President of the Board of Commissioners, Columbus, Ohio, and indorsed Proposals for Gas Fixtures, or Proposals for Locks, etc., as the case may be, and left at the office of the Architect. By order of the Board. T. R. Tinsley, Architect, Columbus, Ohio.

IRON LIGHTHOUSE.—Proposals in duplicate will be received at the office of the Lighthouse Engineer, Fourth District, No. 532 Walnut St., Philadelphia, until 12 o'clock M., Monday, May 15th, 1876, from Iron Manufacturers only, for furnishing all the metal work of superstructure, and for the erection of the same, of two Lighthouses, to be known as Liston's Tree Range Lights, Delaware bay. The right to reject any or all proposals, or to waive defects, if it is deemed for the interest of the United States to do so, is reserved. Drawings and specifications furnished on application at this office. By order of the Lighthouse Board. W. F. Raynolds. Brevet Brigadier General, Engineer Fourth Lighthouse District.

IMPROVEMENTS.—Bids will be received at the City Clerk's office, Columbus, O, until Monday, May 15, at 12 o'clock M. for furnishing materials and doing the following work, to-wit: For building an eighteen inch pipe sewer in Myrtle alley from Broad street to Almond alley. For grading and graveling Fifth avenue; from Summit street to the east corporation line. For grading and bouldering Spring street, from High street to Front street; with Ohio river or bank boulders. For contructing a brick sewer in Town street. from Fair alley to the Scioto river, of the following dimensions: Two feet from Fair alley to Front street, and two and a half feet from Front street to the river. Josiah Kinnear, City Civil Engineer.

IRON WORKS.—The State House Commissioners will receive bids until M of May 4th, to furnish in place, complete, the metallic cornices, caps and covering of the upper dome, including the lantern, and the ornamentation of the Mansard roof, turrets and dome. Separate bids will be received: first, for the roofing and cornice work; second, for the ornamentation. The plans and specifications of said work may be seen, and printed specifications will be furnished, on application at the office of A. H. Piquenard, Acting Architect, in the new State House. Jacob Bunn, John T. Stuart, Jas. H. Beveridge, *Commissioners.*
Springfield, Ill., April 3d 1876.

JAIL.—Bids will be received at Troy by W. A. Woodson, clerk of County Court of Lincoln Co. Missouri, for building a Jail, according to plans and specifications on file in his office, until and including May 8th, 1876. Each bidder to present at said time or before, a certified check, payable to the order of C. W. Martin, presiding justice of said court, in the sum of $100; all checks to be returned except that of the successful bidder, and his check to be also returned if he enters into bond within fifteen days, with approved security, in the sum of $15,000 for the faithful execution of the contract, according to said plans and specifications; otherwise to be forfeited. The contract is to be awarded to the lowest and best bidder, the court reserving the right to reject any and all bids.

OLD IRON RAILS.—Tenders are invited for the purchase of Old Iron Rails, delivered as follows: About 7,000 tons at Toronto, Sarnia, Detroit Junction, or Buffalo. About 1,000 tons at Montreal, or Point Levi, (opposite Quebec). About 3,000 tons at Portland. The company has wharfage accommodation for shipment by water at Toronto, Sarnia, and Portland, and deliveries would be made commencing with May, and extending through the summer. Offers stating the price per ton (of 2,240 lbs.), and the place of delivery, will be received by the undersigned at Montreal, Canada, up to the 15th of May. Joseph Hickson, General Manager, Grand Trunk Railway.

PUBLIC PARKS.—The Standing Committee of the City Council of Toronto, Ontario, on Walks and Gardens, offer $1,050 in Six Prizes for the best plans and scheme for laying out and embellishing the Public Parks of the city, as follows:—

For the Queen's Park, 1st prize	$300
For the Queen's Park, 2d prize	50
For High Park, 1st prize	300
For High Park, 2d prize	50
For the Eastern Park, 1st prize	300
For the Eastern Park, 2d prize	50

Persons competing must submit an estimate of the approximate cost of carrying out the work, which is to be extended over a term of years, and a statement of the manner in which it is proposed to carry out the same. The plans adopted to become the property of the Committee, but the Committee do not bind themselves to accept any plan if they do not consider it of sufficient merit. The plans, etc., must bear a motto without any other mark by which the designer may be known, and be accompanied by a communication, containing the same motto, with the name of the designer, which will not be opened until the prizes have been awarded. They must be left at the office of the City Clerk, City Hall, not later than noon, on Wednesday, the 17th of May next. Plans of the Parks can be seen, and all other information obtained at the office of the City Clerk. P. G. Close, Chairman Walks and Gardens Committee.

REFORM SCHOOL.—The Board of the Ill. Reform School will receive proposals at Pontiac, Ill. up to 4 o'clock, P. M. of Thursday, May 14, 1876, for the erection of one family building, to accommodate fifty boys, in accordance with the plans and specifications to be seen at the bank of Joseph F. Culver & Co., Pontiac, Ills. Bids must be accompanied by a bond of $500 binding the successful bidder to enter into a contract, with a bond of $16,000, for the proper completion of the building according to the plans and specifications. O. Huse, Solon Kendall, Jos. F. Culver, Trustees.

SCHOOL HOUSE.—Proposals will be received by the Board of Directors of the Independent School District of Vinton, Benton Co., Iowa, at the Auditor's office, until 5 o'clock P. M. of May 13, 1876, for the building of a School House in said Independent school district. Said school house to be built in accordance with the plans and specifications on file in the County Auditor's office, Vinton. By order of Board of Directors, A. S. Chadbourne, President, E. M. Evans, Sec.

SCHOOL HOUSE.—Bids for building a brick school house in Independent School Dist. of Hastings, Mills Co. Ia., will be received by the undersigned at his residence in the said district, where plans and specifications may be seen until 2 o'clock in the afternoon of May 13th, 1876. A. P. Provost, Secretary Board of Directors, Hastings, Iowa.

SCHOOL HOUSE.—Bids for building a school house in Sub Dist. 2, and a School House in Sub-Dist. 6, in the township of Cedar, in the county of Mitchell, and state of Iowa, will be received by James Temple in Sub-District No. 2, and Ole O. Haugerud in Sub-District No. 6, until 1 o'clock P. M. on Saturday the 6th day of May. Plans and specifications will be seen at Jas. Temple's and Ole O. Haugerud at Osage, Iowa. By order of the *Board of Directors.*

STREET IMPROVEMENT.—Proposals will be received at the office of the City Clerk, Columbus, Ohio, until Tuesday, May 16, 1876, at 12 o'clock noon, for grading the Roadway of North High street, from Naghten street to First Avenue, in accordance with plans and specifications on file in the City Engineer's office. By order of the Commissioners for the improvement of North High street. H. M. Neil, Secretary.

STREET IMPROVEMENT.—Proposals will be received at the City Engineer's office of Pittsburg, Pa., until Wednesday, the 3d day of May, 1876, at three P. M., for grading Homewood avenue, from Penn avenue to Frankstown avenue. Sewer and Gutter Castings to be delivered for one year, in such quantities, when and where required. Plans and specifications can be seen, and blanks for bidding can be had at this office. No bids will be received after 3 P. M. A. Dempster, City Engineer.

SCHOOL HOUSE.—Proposals will be received by the undersigned up to May 8th, 1876, for the erection of a School House, at New London, Monroe Township, Ind., the building to be constructed as follows, to-wit: To be built of brick, 44 feet square, two stories high, foundation of stone, all to be built of good material and to be completed on or before October 1st, 1876. Contractors can learn full particulars by calling on the undersigned, one-half mile south of New London, on the Russiaville road. Eli Carter. Trustee Monroe Township, Ind.

SEWER PIPE.—Proposals will be received by the Board of Public Works of Chicago, at their office in said city, until 11 A. M., Friday, May 5th, 1876, for laying about 340 linear feet of 12-inch pipe sewer and eight feet of 2-foot sewer on Monroe street, from the centre line of Oakly street westward, with three man-holes on the line of the same, and for furnishing all the materials for the construction of the same, according to plans and specifications on file in said office. R. Prindiville, J. K. Thompson, Louis Wahl, Board of Public Works.

STREET IMPROVEMENT.—Proposals for macadamizing and grading Joliet street from the south side of Sixth street north to the northern terminus thereof, thence east on Ninth street to the west line of Grand de Tour road in the city of La Salle, according to the plans of specifications on file in the office of City Clerk of said city, and also the gravelling of the route aforesaid, together with that portion of said Joliet street between the south side of said Sixth street and the north side of First street in said city, said gravelling also to be done according to said plans and specifications,—will be received by the City Clerk of La Salle, Ills., on or before the hour of 7 o'clock P. M. on Tuesday, May 2, 1876. J. W. Duncan, Mayor of La Salle.

SCHOOL HOUSE.—Proposals will be received by the Board of Directors of the Independent School District of the city of Burlington, Iowa, for the erection of a two-story addition to the "West Madison" School House, until 9 o'clock, A. M. of May 20th, 1876, according to plans and specifications which will be ready for inspection at the office of the Secretary, in Parson's block, on and after April 25th. Separate bids will also be received for window blinds for the whole building. All bids must be signed by the party proposing to do the work, securely sealed, and endorsed, "Proposals for erecting West Madison addition," or "Proposals for blinds." and delivered to the Secretary before the hour above fixed. By order of the Board. Geo. Frazee, Secretary.

STEAM BOILERS.—Proposals will be received at the office of the Kansas State Penitentary in Leavenworth, Kansas, until 2 P. M., May 4th, 1876, for two Tubular Boilers, for heating purposes, 16 feet long by 56 inches diameter, with 40 3-inch flues and otherwise in accordance with specifications on file at the office of E. T. Carr, Leavenworth, or the same furnished on application to this office. Boilers will be required to be set in place and connected. The proposal must include Fire Fronts, steam and mud drums, all valves and connections, and one Blake's No. 3 Steam Pump. Hauling of boilers, etc., from city; all foundations and brick work, and common labor in setting boilers in place, furnished and done without charge to the party contracting. $200 in currency or certificate of deposit must accompany each proposal, as security for compliance with bid, if accepted. Cash paid on completion of work according to contract. By direction of Board of Directors. Henry Hopkins, Warden.

TURNPIKE.—Grading and graveling of the Vossler Pike, running from New Bremen, Anglaize County, west to the Mercer County line, will be let by public outcry at the door of the Town Hall, New Bremen, Ohio, on Tuesday, May 16, 1876, to the lowest and best bidder or bidders. Plans and specifications can be seen at the Auditor's office in said county. The contractor will be required to enter into bonds immediately after the letting for the faithful performance of the work. Sale to commence at 1 o'clock P. M. Samuel Craig, Engineer,

TURNPIKE,—The grading and graveling of the Schmieder Pike about seven and a half miles long, in Jackson Township, Auglaize County, Ohio, will be let by public outcry at the door of the Town Hall, Minster, Ohio, on Monday, May 15, 1876, to the lowest and best bidder or bidders. Plans and specifications can be seen at the Auditor's office in said county. The contractor will be required to enter into bonds immediately after the letting for the faithful performance of the work. Sale to commence at 1 o'clock P. M. Samuel Craig, Engineer.

WATER WORKS.—City Council of Peoria, Ill. invite bids, accompanied with plans and specifications, for building a filter bed at the water works. Bidders will state the plan of filtration proposed, the size and shape of bed, and nature of materials they propose to use. Bids to be left with the city clerk on or before May 24, 1876. Chas. H. Kellogg, Thos. J. Kelly, John P. Cress, Water Works Committee.

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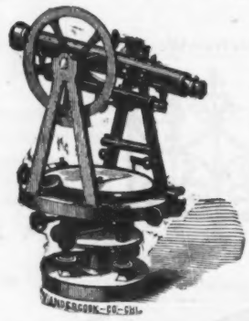

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